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Coupling Element and Use of Said Coupling Element in a Device for Measuring Angles

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The invention relates to a coupling element for connecting two components in a radially resilient, but torsion-proof manner.

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For manufacturing such coupling elements in a cost- effective manner, they are made of one piece and shaped from sheet metal, such as described, for example, in DE 89 15 109 U1, EP 0 762 081 A1 and EP 0 762 082 A1. These coupling elements consist of a flat center piece as the base, and of four brackets, formed thereon by bends. The brackets extend perpendicularly in relation to the level of the base, and respectively two brackets are arranged opposite and parallel to each other and constitute a spring parallelogram for radial compensation. To achieve the function of a spring parallelogram, the brackets extend axially and are formed at one location of the base and can be rigidly connected with one of the two components at another location axially remote from the first. The torsion-proof property is reduced because of this axial remoteness and, in the course of a radial deflection of a spring parallelogram, the base is also unavoidably bent because of the axial linear change of the brackets. In an actual case, the base does not bend symmetrically here because of inhomogeneities in the base, because of which the base introduces an angular twist in the remaining two brackets, which causes a mutual twisting of the two components connected via the coupling element.

It is the object of the invention to create a coupling element which is compactly and space-savingly constructed and can be produced cost-effectively. Moreover, radial compensation movements of the two components connected by means of the coupling element should be possible without introducing impermissible mutual twisting between the two components.

This object is attained by means of a coupling element with the characteristics of claim 1.

The invention furthermore relates to the use of this coupling element in an angle-measuring device.

As mentioned in DE 89 15 109 U1, EP 0 762 081 A1 and EP 0 762 082 A1, coupling elements are employed in angle-measuring devices for the torsion-proof, but radially and axially resilient connection of the scanning unit to a stator of the angle-measuring device. Here, a mutual twisting of the scanning unit in relation to the stator results in a measuring error by the

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angle-measuring device.

It is therefore a further object of the invention to disclose an angle-measuring device, wherein the scanning unit is coupled to the stator of the angle-measuring device in a particularly torsion-proof, but radially resilient manner and, if possible, no measuring errors result from radial compensation movements between the scanning unit and the stator.

This object is attained by means of the angle-measuring device with the characteristics of claim 11.

Particular advantages of the invention are recited in the following description of exemplary embodiments. Advantageous embodiments of the invention ensue from the dependent claims.

Exemplary embodiments of the invention are represented in the drawings.

Shown are in:

FIG. 1, a first exemplary embodiment of a coupling element, viewed in the axial direction,

FIG. 2, a lateral view II - II of the coupling element in accordance with FIG. 1,

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FIG. 3, a stereoscopic representation of the coupling element in accordance with FIGS. 1 and 2,

FIG. 4, a shaft adapter with the coupling element in accordance with the first exemplary embodiment,

FIG. 5, a partial section V - V of the shaft adapter in accordance with FIG. 4,

FIG. 6, an angle-measuring device with the coupling element in accordance with the first exemplary embodiment,

FIG. 7, a second exemplary embodiment of a coupling element, and

FIG. 8, a third exemplary embodiment of a coupling element in a stereoscopic representation.

A first exemplary embodiment of a coupling element 1 is represented in FIGS. 1 to 3. The coupling element 1 has been produced in one piece as a punched and bent element and is made of a material with a high degree of alternating stress resistance, in particular of spring steel. It consists of a flat center area as the base 2, as well as four brackets 3, 4, 5, 6 formed thereon and bent at right angles. The brackets 3, 4, 5, 6 are aligned, at least to a large degree, parallel in relation to the axis D, they are furthermore arranged diametrically opposite each other and parallel with each other. The bracket 3 is arranged diametrically opposite and parallel with the bracket 5. The bracket 4 is also arranged diametrically opposite and parallel with the bracket 6, wherein the brackets 3 and 5 extend at right angles to the brackets 4 and 6.

Each bracket 3, 4, 5, 6 is fixed, centered atop a support on the base 2, and each bracket 3, 4, 5, 6 has respective further support points 3.2, 3.3, 4.2, 4.3, 5.2, 5.3, 6.2, 6.3 on both sides of these support points 3.1, 4.1, 5.1, 6.1. The diametrically oppositely located support points 3.2, 3.3 and 5.2, 5.3 are used for the rigid fastening of the brackets 3, 5 on one of the two components, and the diametrically oppositely located support points 4.2, 4.3 and 6.2, 6.3 are used for the rigid fastening of the brackets 4, 6 on the other of the two components. All support points 3.1 to 6.3 advantageously lie in a common plane. The support points 3.1, 4.1, 5.1, 6.1 are formed by bending lines between the base 2 and the brackets 3, 4, 5, 6. The support points 3.2, 3.3, 4.2, 4.3, 5.2, 5.3, 6.2, 6.3 are embodied as bores for fastening by means of screws, wherein the centers of the bores are located together in the center plane of the base 2. However, other rigid fastening methods, for example welding, can also be provided. The three support points 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 6.1, 6.2, 6.3 of each bracket 3, 4, 5, 6 are advantageously located on a common straight line, wherein the extensions of the straight

lines enclose a rectangular square.

The base 2 advantageously consists of four braces, which connect the support points 3.1, 4.1 and 4.1, 5.1 and 5.1, 6.1, as well as 6.1, 3.1 in one plane and enclose a square. In this case the center lines of the braces extend at least approximately in the direction of the lines of application of the force which is introduced at the support points 3.1, 4.1, 5.1, 6.1.

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This described coupling element 1 can be employed in connection with angle-measuring devices in that it is inserted between the shaft of a drive mechanism and the shaft of an angle-measuring device. A shaft adapter 9 with the coupling element 1 in accordance with FIGS. 1 to 3 is represented in FIGS. 4 and 5. The coupling element 1 can be inserted in a particularly simple way between the shaft of the drive mechanism to be measured and the shaft of the angle-measuring device by means of this shaft adapter 9. The shaft adapter consists of a first flange 9.1, on which the shaft of the drive mechanism can be rigidly fastened, and of a second flange 9.2, on which the shaft of the angle- measuring device can be rigidly fastened. In the example represented, the first flange 9.1 is a plate with bores 9.11, so that the plate can be fixed in place on the shaft of the drive mechanism by being screwed together with it. The second flange 9.2 consists of a second plate with a centered bore 9.21, in which the shaft of the angle-measuring device can be fixed in place by radial clamping.

The two outer support points 6.2, 6.3 and 4.2, 4.3 of the two diametrically oppositely located brackets 6 and 4 are rigidly connected with the first flange 9.1 by means of screws 8, and the two outer support points 3.2, 3.3 and 5.2, 5.3 of the brackets 3 and 5 extending at right angles to them are rigidly connected with the second flange 9.2 by means of screws 7. The two flanges 9.1, 9.2 are connected with each other via the coupling element 1 in a radially and axially resilient, but torsion-proof manner, in relation to the axis of rotation D. For reasons of clarity the support points of the brackets 3 to 5 have not been provided with reference symbols, reference is made with respect to this to FIG. 3. The shafts of the drive mechanism and of the angle-measuring device have also not been represented for reasons of clarity.

The use of the coupling element 1 is particularly advantageous for the torsion-proof, but axially and radially resilient connection of a scanning unit 20 of an angle-measuring device to a stator 10 of this angle-measuring device. This application is represented in partial section in FIG. 6.

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In a known manner, the angle-measuring device consists of a stationary part, also called mounting flange, of the angle- measuring device, or stator 10 in general, a scanning unit 20 and

a rotating element, also called a rotor 30. The rotary position of the rotor 30 with respect to the stator 10 is measured. The rotor 30 in turn consists of a shaft 31, which is seated in the scanning unit 20 and on which a code disk 32 is fastened. The scanning unit 20 consists of a support body 21, on which a light source 22, a scanning plate 23 and a receiver unit 24 for the photoelectric scanning of the code disk 32 are arranged. The stator 10 can also be the stationary portion of a drive mechanism. for example the mounting flange of a motor, on which the scanning unit is installed.

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The shaft 31 of this angle-measuring device can be rigidly installed on a shaft to be measured, because alignment errors are compensated by the coupling element 1, which is integrated into the angle-measuring device. For this purpose, the brackets 4 and 6 are rigidly fixed in place on the stator 10 of the angle measuring device via the support points 4.2, 4.3, 6.2, 6.3. Only one of the screws 7 used for this is represented. The brackets 3 and 5 of the coupling element 1 are rigidly fixed in place on the scanning unit 20 by means of screws 8 via the support points 3.2, 3.3 and 5.2,. 5.3. Because of alignment errors between the shaft to be measured, not represented, and the shaft 32, the scanning unit 20 performs tumbling movements in relation to the stator 10, which are compensated by the coupling element 1 without the scanning unit 20 performing a rotation around the axis of rotation D in the process. If in the course of the rotation of the shaft 31 the scanning unit 20 is displaced in the radial direction R because of alignment errors, the support points 3.2, 3.3 and 5.2, 5.3 of the brackets 3 and 5 are displaced in this direction R with respect to the support points 3.1 and 5.1. Because of the symmetrical arrangement of the support points 3.2, 3.3 with respect to the center support point 3.1, as well as the support points 5.2, 5.3 with respect to the center support point 5.1, this displacement does not introduce a rotating movement into the coupling element 1. The actually occurring displacements are so small that they are compensated by the symmetrical stretching of the brackets 3 and 5 in the circumferential direction. In connection with displacements of the scanning unit 20 in the radial direction perpendicular to R, the support point 6.1 is radially moved with respect to the support points 6.2 and 6.3, and the support point 4.1 is also radially moved with respect to the support points 4.2 and 4.3. The changes in distance occurring here between the support points 6.2, 6.1, 6.3 of the bracket 6, and between the support points 4.2, 4.1, 4.3 of the bracket 4, are again compensated by the symmetrical stretching in the brackets 6, 4.

If the scanning unit 20 is also displaced in the axial direction because of tumbling

movements of the shaft 31, this movement is compensated by the base 2.

The angle-measuring device can be an incremental angle encoder - preferably of the photoelectric type -, an absolute value encoder or a resolver.

It has been shown that the transfer behavior of this coupling element 1 is improved in comparison with known couplings, along with cost-effective manufacture and space-saving installation options. The coupling element 1 has a high vibration resistance because of the low mass, very good angular transfer accuracy and good thermal behavior. It can be cost-effectively produced and installed as a punched and bent element and is insensitive to fluctuations in the thickness of the material and strength in the area of the four center connecting braces, because these always remain flat during a radial deflection of the coupling element. It is therefore also possible to easily optimize the radial and axial stiffness independently of each other by varying the sheet metal thickness, or by the application of stiffening bends, for example in the form of beads or by crimping of the base 2.

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A second exemplary embodiment of a coupling element 1 is represented in FIG. 7. Since it essentially corresponds to the first exemplary embodiment, the same reference symbols are used and the description is limited to the differences. If particularly strong axial stiffness is demanded, the base 2 can be mechanically reinforced by means of the application of beads 2.1. If an axial fastening of the sheet metal brackets 3, 4, 5, 6, which are bent at right angles in relation to the base, is demanded, the ends with the support points 3.2, 3.3, 4.2, 4.3, 5.2, 5.3, 6.2, 6.3 can be bent over into the plane of the base 2. All support points 3.1 to 6.3 (centers of the fastening points) again lie in a common plane.

The further exemplary embodiment in accordance with FIG. 8 shows a coupling unit 100, wherein the brackets 103 to 106 are formed on the base 102 by means of their ends being bent at right angles, wherein the support points 103.2, 103.3, 104.2, 104.3, 105.2, 105.3, 106.2, 106.3, which are formed by the bending lines, are located in a common plane, in which the further support points 103.1, 104.1, 105.1, 106.1, which are symmetrically arranged between these support points 103.2 to 106.3, also lie. The center support points 103.1, 105.1 of the brackets 103, 105, which are located parallel across from each other, are used for fastening on one component (for example the first flange 9.1 in accordance with FIG. 4, or the stator 10 in accordance with FIG. 6), and the center support points 104.1, 106.1 of the further brackets 104, 106, which are located parallel across from each other, are used for fastening on the further two components (for example the second flange 9.2 in accordance with FIG. 4, or

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the scanning unit 20 in accordance with FIG. 6).

In a manner not represented it is also possible to arbitrarily combine the details of the coupling elements 1, 100, represented in FIGS. 3, 7 and 8, for example, a coupling element can have two brackets 3, 5 in accordance with FIG. 3, and two oppositely located brackets 104, 106 in accordance with FIG. 8, which are arranged perpendicularly to the first.

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The described coupling elements 1 and 100 have optimal dimensions, if all support points (3.1 to 6.3, 103.1 to 106.3) are located on a common straight line, and if furthermore all support points (3.1 to 6.3, 103.1 to 106.3) of all brackets (3, 4, 5, 6, 103, 104, 105, 106) are located in a common plane. For reasons of the available fastening opportunities it may be necessary to arrange the center support points slightly axially offset (parallel with the axis D) with respect to the further support points. The effect in accordance with the invention of the coupling element is preserved, if the flexural strength of the brackets 3, 4, 5, 6 between the respective center support points 3.1, 4.1, 5.1, 6.1 and the connecting line with the further support points 3.2, 3.3, 4.2, 4.3, 5.2, 5.3, 6.2, 6.3 (course of the brackets in the axial direction, also parallel with axis D), is considerably greater than the flexural strength between the center support points 3.1, 4.1, 5.1, 6.1 and the two further support points 3.2, 3.3, 4.2, 4.3, 5.2, 5.3, 6.2, 6.3 (course of the brackets in the circumferential direction, i.e. transversely to the axis D), so that in case of a radial displacement of the further support points with respect to the center support point, the brackets are respectively bent between the two further (outer) support points and are therefore stretched.

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